Marine Fisheries Service's Galveston Laboratory or on wild ridley stocks in the Gulf of Mexico. Research emphasis should be directed toward head starting, morphometry and growth, ecology and/or stranding.

Fellowship applicants must meet academic acceptance standards of the Texas A&M University Graduate College. Students interested in applying for the HEART/TAMU Ridley Fellowship should contact Dr. Andre M. Landry, Department of Marine Biology, Texas A&M University, PO Box 1675, Galveston, TX 77553 USA. The Fellowship will be awarded by 1 January 1986.

GUEST EDITORIAL -- SEA TURTLE SEX RATIOS AND INCUBATION TEMPERATURE: ARE WE ON THE RIGHT TRACK?

There is a considerable body of evidence indicating that the two sexes in turtles are genotypically different at the molecular level, even though the sex chromosomes may not be morphologically distinguishable by microscopic examination. In most turtle species, the female apparently has the heterozygous genotype (ZW) and the male is homozygous (ZZ) (Sites et al., 1979; Bull & Vogt, 1979; Zaborski et al., 1979; Bickham et al., 1980; Bull 1980, 1983; Engel et al., 1981; Bickham and Carr, 1983), although Carr and Bickham (1981) give evidence for male heterogamety in the Asian pond turtle, Siebenrockiella crassicollis. For some species, incubation temperature may have little or no effect on sex ratios (Bull et al., 1985); however, the expression (phenotype) of sex in marine turtles seems controlled to a large extent by incubation temperature (Harvey & Slatkin 1982; Limpus et al., 1982; Mrosovsky et al., 1984a,b; Dalrymple et al., 1985; Dutton et al., 1985; Standora & Spotila, 1985). Therefore, it appears that incubation temperature can override or at least modify the influence of genotype in determining the sex of an individual sea turtle. In other words, certain incubation temperatures apparently produce individuals that exhibit discordance between sex genotype and phenotype, and such individuals are said to be "sex-reversed" (Zaborski et al., 1982; Wachtel 1983; Ohno et al., 1984; Nakamura et al., 1984). If this is true, there are four possible outcomes of temperature-determined sex (not including "intersexes"), regarding the genotype and phenotype of an individual sea turtle:

Genotype (Chromosomal)	Phenotype (Gonadal)
Male	Male
Female	Female
Male	Female
Female	Male

The first two represent concordance between genotype and phenotype, and the latter two represent sex-reversed individuals. Perhaps additional categories could be listed to represent intergradations reflecting intersexes, but the intent of this editorial is to focus attention on the possible effects of sex-reversal (genotype-phenotype discordance) on sea turtle persistence and reproductive efficiency.

Management concerns and recommendations have been based on the implicit assumption that if sex reversal takes place, sex-reversed individuals have the same potential for persistence and reproduction as do those that exhibit genotype-phenotype concordance (Mrosovsky & Yntema 1981; Morreale et al., 1982; Mrosovsky 1983). If this assumption is not true, the recommendations might be misguided. In addition, the question may have significance with regard to the low hatching success rates reported in second-generation captive-reared sea turtles (Wood & Wood, 1982). We emphasize that the consequences of current conservation and management practices could be different than supposed, should sex-reversed turtles not have persistence and reproductive potential similar to those of non-sex-reversed turtles.

The presumed mechanism of sex determination in sea turtles (i.e., sex phenotype determined by incubation temperature, regardless of genotype) is critical to our message. However, if sex determination were by a different mechanism, it might negate concern about sex-reversal. Suppose, for sake of example, that both sexes are identical in sex genotype (i.e., they are identical and indistinguishable with regard to the sex genes). Suppose further that the sex phenotype were solely determined by some environmental influence (incubation temperature) operating on the sex-inducing system within this genome. If this were true, there would be no such thing as sex-reversal and the influence of sex ratio on survival of the species would operate entirely through the species' nesting strategies (i.e., site selection, seasonal timing, etc.). Sex-reversed individuals would not exist because the sex genes would have the same potential for either sex; environmental influences would be the sole determinants of sex ratios for the species. However, there might be intersexes produced near the pivotal incubation temperatures.

The literature does not support these suppositions, because male and female turtles apparently have different sex genes, at least at the molecular level, and in a few cases, sex chromosomes are morphologically different. Standora and Spotila (1985) state that for turtles a simple ZZ-ZW system with sex reversal is unlikely, but they do not go so far as to suggest that there are no genotypic differences between males and females. Therefore, the question remains as to the impact of temperature-induced sex reversal on persistence and reproduction in sex-reversed individuals as compared to their non-sex-reversed comrades.

Determination of the sex genotype and phenotype of individuals from samples of sea turtles taken from wild and captive stocks is needed to determine frequencies of each genotype-phenotype combination, as the first step in investigating the consequences of sex-reversal. Next, it would be necessary to determine whether sex-reversed individuals have lower survival rates or reproductive capacities than do those individuals that are not sex-reversed. Captive stocks offer the best opportunity for this determination. Results would determine whether or not the consequences of temperature influence on sex ratios in marine turtles should be reconsidered with regard to conservaion and management strategies. Obviously, any such research would be long-term.

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